

The Effect of Date of Planting on the Performance of Promising Cotton Varieties

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ABSTRACT
An experiment to test the effect of date of planting on the yield of new advanced lines of cotton from the crops improvement programme at the Savannah Agricultural Research Institute (SARI) was conducted at Nyankpala between May and December 2000. Three cotton lines, namely; Sarcot 4, Sarcot 5 and Sarcot 10 as well as FK290, a commercial variety were each planted on five different dates follows: May 26, June 9, June 23, July 7 and July 21. The experiment was implemented in a split plot design with three replicates. The crops were planted at a spacing of 90cm x 30cm. The results of the experiment showed that early planted cotton varieties yield better than late planted ones. Late planted crops suffered more bollworm damage than early planted ones. The Sarcot lines used in this study responded well to earlier dates of planting than the late ones. Early planting is therefore recommended to farmers in the study area. However, planting should not be done too early (as early as May) since bolls will start opening September when it will still be raining heavily and will definitely affect the quality of the lint negatively.
Key Words: Cotton, Varieties, Effect, Date of Planting, Performance

1.0 INRODUCTION

Cotton, the world most important non-food agricultural commodity was one of the first vegetable fibres used for textile purposes. It is believed to be a native of Asia and South America, from where it spread to other parts of the world. In Ghana, the Bassel Missionaries introduced it in the seventeenth (17th) century.
The importance of cotton in this modern world cannot be over emphasized. Apart from the lint, which the textile industry uses for the manufacture of fine clothes, a substantial amount of oil is also obtained from the seed.
In Ghana and especially, in the northern parts of the country, cotton is recognized as one of the most important cash crops. In northern Ghana, cotton offers employment to a large number of people.
Out of one hundred and thirty (130) farmers interviewed in the Wa district of the Upper West region of Ghana on the importance of cotton farming, not even a single farmer gave a bad testimony about cotton farming. Forty (40) farmers were able to put up houses out of cotton farming, forty-three (43) farmers acquired property such as bicycles, sewing machines, and household utensils, thirty-five (35) farmers acquired livestock (cattle, sheep and goats), four (4) farmers bought grinding mails and two bought motor bikes though cotton farming. Almost all the farmers interviewed except the unmarried, said they have been able to fund their children's education through the cotton farming (Wumbei *et al*., 1999). Masahudu Dorie, a farmer, said that it is only through cotton farming one can get a big income at the end of the farming season.
The principal cotton-growing areas in Ghana are the Northern, Upper East and the Upper West region. Other areas where cotton can be grown include; the coastal savanna zone, parts of Volta, northern Ashanti and Brong-Ahafo regions. A monomodal rainfall with a very long dry season characterizes the three principal cotton-growing areas mentioned above.
The production of cotton in the world is greater than all fibres put together. The trend of cotton production in Ghana is quite encouraging. From 1989 to 1991, Ghana produced an average of 898 kg ha-^{1} of seed cotton. This figure fell to 853 kg ha-^{1} in 1996 and again rose to 943 kg ha-^{1} in 1997 and 1998 respectively (FAO, 1998).
The evolution of the cotton industry in Ghana from 1995 to 2000 showed that, the Ghana Cotton Company Limited (GCCL) alone produced a total of 11,125 tons of seed cotton in 1996, 15,070 tons in 1997, 20,243 tons in 1998, 24,100 tons in 1999 and 25,000 tons in 2000 (unpublished data from cotton companies). This shows that production is increasing mainly by putting more land to cotton rather than a drastic increase in productivity per unit area.
Cotton is planted within a wide range of time, usually from mid may to the end of June. However, in most cotton growing areas especially in the northern region, this time of planting cotton conflicts with land preparation, planting and weeding of food crops. This normally leads to a situation where farmers plant cotton too early and pay less attention to it or plant very late, both of which in turn lead to poor yields and poor quality of the cotton produced.
Sement (1988) in his book, "cotton" said "Even though it is often difficult for the grower to plant cotton at the proper time due to his priority to his food crops, he should be aware, that in the Sahel and Sudan zones, yield prospects decline very sharply if sowing takes place very late". This calls to investigate when it is very late to plant cotton in the guinea savanna zone. Planting too early also leads to opening of bolls when the rains have not

ceased. Cotton which has weathered due to exposure to open bolls to excessive rain, deteriorate and become more susceptible to fibre breakage during processing (Hake et al., 1990). Kerby, 1996, reported that, cotton bolls set late in the season, suffer increase short fibre content. However, unpublished information from the Ghana Cotton Company Limited, Tamale and the Plantations Development Limited, Wa, showed that early planted cotton varieties often yield better than late planted cotton.

This project was therefore, undertaken to verify the above hypotheses.

2.0 Objective (s)

The objective of the study was to determine the effect of five dates of planting on yield parameters of three promising cotton lines selected at the Savanna Agricultural Research Institute (SARI) and one commercial variety grown extensively in Ghana.

3.0 METHODOLOGY

The trial was conducted on the experimental field of the savanna Agricultural Research Institute (SARI) at Nyankpala (Altitude 183m, Latitude 9^{o} 25' N and Longitude 0^{o}58' W).

Three cotton lines; Sarcot 4, Sarcot 5, Sarcot 10 and a commercial variety, FK290 were each planted on five different dates. The SARI Cotton Improvement Programme developed the Sarcot lines while FK290 is a commercial variety originally from Burkina Faso and Grown by the cotton companies in Ghana.

3.1 LAND PREPARATION: Ploughing was done to a depth of 20cm followed by harrowing to produce a good seedbed. Before each planting, the plots were leveled with the use of hoes.

3.2 PLANTING: Planting was done to a depth of 3cm and at a spacing of 90cm between rows and 30cm within rows. Planting was done at two weeks interval with the first planting being on the 26th of May and the fifth planting on July 21, 2000.

3.4 FIELD LAYOUT: The experiment was implemented in a split plot design with three replications and two factors (variety and date of planting). Variety (four levels) was assigned to the main plot and date of planting (five levels) was assigned to the sub-plot. In all, there were sixty- (60) experimental units with each plot size being 5m x 2.7m.

3.5 CULTURAL PRACTICES

Weeding: A total of four, weeding were done on each plot. First weeding was done two weeks after planting (2WAP) and the subsequent ones done whenever there was the need. Weeding was done with a hoe.

Fertilizer application: NPK fertilizer was applied at the ratio of 70:30:30. Nitrogen was applied in split doses. The first dose of 40 kg ha^{-1} was applied together with the phosphorus and potassium 3 WAP the second dose of 30 kg ha^{-1} was top dressed at squaring.

Spraying: Spraying was done as and when there was the need to do so. In all six sprayings were conducted using K-D brand insecticide (active ingredients: *Lambda cyhalothrin* and *Chlorpyrifos*) at the rate of 1 litre ha^{-1}.

Harvesting: Harvesting was done by hand picking of seed cotton from completely opened bolls on the whole plot. In all, a minimum of three pickings was done on each plot.

3.6 DATA COLLECTED

The following data were taken:

- The dates of emergence, squaring, flowering and boll opening;
- Degree-days accumulated at the phonological stages above;
- Boll period, boll weight and number of bolls per plant;
- Plant height at flowering;
- Rainfall and temperature;
- Yield loss due to bollworms assessment.

The temperature and rainfall data over the study period were obtained from the SARI meteorological station. The degree-days (DD) other wise known as heat units were calculated by subtracting a base temperature of 17°C from the daily mean temperature. The cumulative rainfall of the major phonological stages was also calculated from the rain fall data.

3.7 DATE ANALYSIS

The data of the trial was subjected to the ANOVA using "STATISTIX" for windows (Analytical software, 1996) and the means were compared using Fisher's LDS. The means were placed in homogenous groups represented by alphabets indicating means that belong to the same group (therefore are not significantly different from each other) or to groups that overlap or to different groups that are significantly different from each other.

4. 0 RESULTS

4.1 Uniformity in Seed Emergence

Uniformity in seed emergence is the average number of seedlings (stands) out of a hundred (100) that emerges in a day. Emergence prolonged over a period and the uniformity differed among varieties ($P<0.05$) and dates of planting ($P<0.001$). There was no interaction between the varieties and the dates of planting for this parameter. The Sarcot lines did not statistically differ in uniformity in emergence among themselves. However, they had superior uniformity in emergence over FK 290 as shown in table 1.

Table 1: Uniformity in Seed Emergence of Four Cotton Genotypes at Nyankpala, 2000.

Variety	**Uniformity in Seed Emergence, %**
Sarcot 5	14.0 a
Sarcot 10	13.8 a
Sarcot 4	13.7 a
FK 290	12.5 b

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.05.

The highest uniformity was observed when the varieties were planted on June 23 and the least on July 7.

Table 2: Uniformity in Seed Emergence of Cotton sown on Different Dates at Nyankpala, 2000.

Date of Planting	Uniformity in Seed Emergence, %
June 23	27.6 a
June 9	18.8 b
May 26	7.9 c
July 21	7.4 cd
July 7	5.6 d

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.001.

4.2 Degree-days (DD17) Accumulated at Major Phonological Stages.

The time taken for a crop to attain the different growth stages is influenced by the amount of effective temperature accumulated by the crop amongst other factors. It is expressed as thermal units and it is otherwise known as degree-days (DD).

4.2.1 DD17 at Squaring, Flowering and Boll Opening

The amount of heat units (DD17) accumulated at squaring, flowering and the boll opening stages of the crops were influenced by the date of planting significantly ($P<0.00$, $P<0.05$, and $P<0.01$ respectively) and not by varieties used. At squaring the crops planted on the different dates were significantly different from each other as far as heat unit accumulation was concerned. At flowering, crops planted on Jul 21 recorded the highest DD17. The June 23, June 9 and May 26 crops accumulated significantly less heat units than July 21 crops to attain flowering. The same pattern was observed at boll opening (Table 3).

Table 3: Degree-days (DD17) Accumulated from Different Planting Dates to Squaring, Flowering and Boll Opening

Planting Dates	*****Squaring**	***Flowering**	*****Boll Opening**
July 21	1029 a	1526 a	1679 a
July 7	901 b	1342 ab	1444 ab
June 23	704 c	848 b	1296 b
June 9	561 d	695 b	1166 b
May 26	494 e	605 b	1027 b

**** Figures followed by the same letters are not significantly different at a rejection level of 0.001.*
**Figures followed by the same letters are not significantly different at a rejection level of 0.05*

4.3 Cumulative Rainfall at Squaring, Flowering and Boll Opening

The cumulative rainfall at squaring, flowering and boll opening were affected solely by the dates of planting ($P<0.001$). The LSD mean comparison of the cumulative rainfall separated the dates of planting at each of the phonological stages into three homogeneous groups. At each of the three stages, crops planted on June 9 had the highest cumulative rainfall (Table 4).

At squaring, crops planted on June 23, July 7 and July 21 had not significantly accumulated different rainfall values from each other. However, the values were significantly different from the June 9 and May 26 crops. At boll opening the two July crops had accumulated significantly lower rainfall than the rest.

Table 4: Cumulative Rainfall (mm) from Planting to Different Reproductive Growth Stages in Cotton at Nyankpala, 2000

Planting dates	Squaring	Flowering	Boll opening
June 9	298 a	370 a	651 a
June 23	231 b	303 b	552 b
July 21	222 b	352 a	455 c
July 7	206 b	245 c	464 c
May 26	126 c	366 a	529 b

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.001.

4.4 Plant Height

The plant height taken at flowering was significantly influenced by variety ($P<0.001$). No interaction was observed between the varieties and the dates of planting. Sarcot 5 showed superiority over Sarcot 10 as far as height was concerned (Table 5).

Table 5: Average plant height of 4 cotton varieties sown on 5 different dates in 2000 at Nyankpala

Variety	Plant height, cm.
Sarcot 5	71.9 a
FK 290	68.9 ab
Sarcot 4	65.5 ab
Sarcot 10	62.7 b

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.01.

Crops planted on June 9, July 21, July 7 and May 26 were not significantly different in height at flowering from each other, but were significantly different from those planted on June 23 as can be seen in table 6.

Table 6: Average Plant Height of Cotton Grown on Different Dates in 2000, Nyankpala

Planting Dates	**Plant Height (cm)**
June 23	80.7a
June 9	68.6b
July 21	67.0b
July 7	60.7b
May 26	59.3b

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.001.

4.5 Seed Cotton Yield

There was no statistical difference in yield among varieties. However, there were significant variations in yields of the crops planted on different dates ($P<0.001$). The LSD mean-comparison put the dates of planting into three homogeneous groups. The July 21 crop yielded the least amount of seed cotton and was significantly different from yields of the first two crops planted on May 26 and June 9 (Table 7). Seed cotton yield strongly correlated negatively with the amount of heat units accumulated at 2 WAP ($r = 0.74$), squaring ($r = 0.73$) and at boll opening ($r = 0.62$). It also strongly correlated negatively ($r = 0.72$) with the date of planting (Appendix 10).

Table 7: Seed Cotton yield of Crops Grown on Different Dates at Nyankpala, 2000

Planting Dates	**Seed Cotton Yield, kg ha-1**
May 26	3956 a
June 9	3599 a
June 23	3420 ab
July 7	2180 ab
July 21	1340 ab

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.001.

5.6 Yield Loss Due to Bollworms

The percentage yield loss as a result of bollworm damage was significantly influenced by both variety ($P<0.001$) and date of planting ($P<0.05$). Sarcot 10 crops were less tolerant to bollworms while Sarcot 5 crops showed much tolerance (Table 8).

Table 8: Percentage yield loss due to Bollworms on four cotton varieties grown at Nyankpala in 2000.

Variety	Yield Loss, %
Sarcot 10	18a
Sarcot 4	16ab
FK 290	15ab
Sarcot 5	13b

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.001.

Bollworm damage on crops planted on June 9 and June 23 was not significantly different from each other and was significantly lower than on those planted on July 7 and July 21 (Tabale 9).

Table 9: Percentage Yield Loss Due to Bollworms on Cotton Crops Planted on Different Dates at Nyankpala, 2000

Planting dates	Yield loss, %
July 21	17.2a
July 7	17.1a
May 26	15.0ab
June 9	14.5b
June 23	14.2b

NB: Figures followed by the same letters are not significantly different at a rejection level of 0.05.

6.0 DISCUSSION

6.1 Crop Development

Crop emergence and establishment were dictated mainly by moisture availability. There were marked significant differences in the days it took for the cotton crops to emerge due to the dates of planting than observed among the varieties (Tales 1 and 2). From the uniformity in seed emergence data, while it would have taken the three Sarcot lines about 7 days to attain 100% emergence of stands and 8 days for the FK 290 variety on the average across the five dates of planting, it would also have taken approximately 3.6 to 18 days for the crops sown on the different planting dates to attain 100% emergence of stands in the field.

This can be attributed to the occurrence of dry spells that are characteristic of the agro ecological zone during the wet season. A dry spell in this area is a period of 5 days or more with less than 5mm day^{-1} of evapotranspiration (Kasei and Sallah, 1997).

The July 7 crop with a uniformity of emergence of 5.6% would have taken the longest time of approximately 18 days to attain 100% emergence of stands barring seedling damage by pest and diseases. The crop was planted when a 5-day dry spell had just been broken and it went through two other dry spells lasting for 5 and 13 days respectively. The May 26 and July 21 crops were also planted during a dry spell but they had more favourable conditions in the first 2-week period after planting. The May 26 crop was planted when a 6-day dry spell had began only two days earlier. The crop however, had 6 rainy days by 14DAP while the July 21 crop was planted during a 13-day dry spell that had began 8 days earlier and had 5 rainy days during the first 14DAP.

The crops planted in June had the most favourable weather conditions to emerge and establish unlike those planted in July. The June 9 crop was planted 2 days before an 8-day dry spell began however it had as much as 9 rainy days during its first 14 DAP. The June 23 crop never went through a dry spell till 8 DAP this is why it had potentially only 3.6 days to attain 100% emergence of stands from the uniformity of 27.6%.

The unfavourable weather conditions of the two July crops made them to accumulate significantly higher DD17 values than the three earlier crops during their first 14 DAP for all the varieties used. Most of the heat units accumulated did not meet favourable moisture regimes to effect growth development in time.

The month of July in 2000 registered three dry spells. According to Kasei and Sallah (1997) the probability of having a 7-day dry spell in June are once every year and twice every 3 years for July. There have been 67 and 70 dry spells experienced in June and July respectively in this area from a long-term data spanning from 1953-92 (a 40-year period). Most of the dry spells in June occur during the second half of the month, this makes the period from the last week in June till the second week in August the most prone to dry-spells in the area. This is definitely not the best time to plant cotton a crop that spends the first 15 days to develop an elaborate root system before shifting emphasis on growth of the above ground parts (Shleikher, 1983).

There were significant differences in the development of the crops due to the different planting dates. The development of the May 26 crops was fastest till squaring and thereafter was among the fastest. These crops attained the major phonological stages with the accumulation of the least DD17 (Table 3).

Squaring in the May 26 crops was attained with only 494^{o}C of heat units and only 126 mm of rain. Within the period of boll development (from massive flowering to boll opening) the crops planted in May-June accumulated as much as 422^{o}C - 471^{o}C of DD17 compared with 102^{o}C and 153^{o}C for the July 7 and July 21 crops respectively (Table 3). These definitely translated in well-developed bolls on the May-June crops as evident from the yield data (Table 7). During the same period, rainfall was not limiting for the crops, as there was 163mm of rain for the May 26 crops while the July 7 and July 21 crops had 219mm and 103mm of rain. The June crops had in excess of 245mm of rain (Table 4). Clearly the July 21 crop was late and could not take advantage of the October rains in boll development before the characteristic abrupt end of the rains in that month.

The fast development of the May 26 crops through the growth stages resulted in relatively short plants at flowering (Table 6). The July 7 crops however due to their slow growth rate through 5 dry spells before flowering ended up equally as short plants. This was in contrast with the general view held that when crops are planted early they are able to accumulate more DD17 there by producing more biomass.

No significant differences were observed among the varieties with regards to the duration on the development stages. However, at flowering Sarcot 5 crops stood out averagely taller than Sarcot 10 in the field (Table 5).

6.2 Seed Cotton Yield

Seed cotton yield correlated negatively with the amount of heat units accumulated at 2 WAP (r = 0.62). The longer it took the crops to attain the growth stages the lower the yields. It also correlated negatively (r = 0.72) with the date of planting (Appendix 1). The later the cotton crop was planted the lower the yield obtained.

Late planting resulted in lower seed cotton yields explaining about 52% of variations in yields rather than the varieties used (Appendix 1). The May 26 crops yielded more than the other dates of planting. They yielded averagely 3956 kg ha^{-1} as compared with 1340 kg ha^{-1} for the July 21 crops (Table 7). These variations in yield could be attributed to factors such as; temperature, rainfall and pests (bollworms) damage.

The longer boll period (48 days) of the May 26 crops with optimal levels of moisture and effective heat resulted in higher yield than the July 21 crops with a shorter boll period of 40 days. The boll periods for the other dates of planting were as follows; June 9 – 47 days, June 23 – 46 days and July 7 – 45 days. From this, a delay of 14 days in planting from May 26 to July 7 resulted in the boll periods reducing by a day. Beyond July 7, a delay of 14 days in planting cotton resulted in a 5-day reduction in boll period.

Generally, early-planted cotton crops receive a combination of adequate temperature and rainfall regimes than late planted ones. Boll size (weight), which is a component of yield in cotton, is greatly influenced by weather and the duration of boll development stage of the plant. For instance, a cotton plant will bear small bolls if there is hot weather during bloom, cold weather during boll maturation and if bolls are set late in the season (Hake et al., 1990). This was not different from what was observed on the field. For instance, the July 21 crops which flowered in September (accumulating only 103mm of rains before cut-off) had an average boll weight of 6.9g, compared with an average boll weight of 7.3g for the May 26 crops which attained its flowering in July (with a total rainfall of 163mm to cut-off). This variation in boll size explains why the May 26 crops yielded more than the July 21 crops.

Pest damage is another factor that can affect yield. Yield loss due to bollworms was influenced by the varieties used and date of planting. Sarcot 5 crops suffered the least yield loss due to bollworms attacks than the other varieties (Table 8) giving the implication that they have higher resistance to bollworms attack.

The least yield loss due to bollworms was recorded in the earlier crops, especially the June crops (Table 9). There must have been an escape mechanism from bollworm infestation by planting earlier than July. The higher rainfall and greater number of rainy days in May and June may probably have washed eggs laid by the moths off the cotton plants and off the fields through run-offs preventing them from hatching. The month of June 2000 had 14 rainy days with a total of 260mm of rainfall and May had 162mm of rains falling on 9 rainy days as compared to 6 rainy days in July giving a total rainfall of 97mm.

7.0 CONCLUSION AND RECOMMENDATIONS

Weather conditions, especially moisture availability influenced the rate of seed emergence in the field more than the other developmental stages. It is therefore advisable to choose dates of planting falling in periods when the probability of dry spells are low.

A good uniformity in stand emergence resulted in taller plants but taller plants did not necessarily translate into better yields in this study.

Early planting resulted in a faster rate of growth into the reproductive phase and allowed the bolls to develop under adequate moisture and heat regimes translating into higher yields. This implies that early planting of cotton as believed by some people, really yield more than late planted cotton.

The Sarcot lines used in this study responded well to earlier dates of planting than the late ones.

Planting cotton earlier than July resulted in low levels of yield loss due to bollworm infestation under the current rates of pest control used by the cotton companies.

Following the results obtained, one would advise farmers to always plant early. However, planting should not be done too early as in this investigation (as early as May 26), for it was realized that the bolls of May 26 crops started opening in September when it was still raining heavily (total rainfall for the month was 213mm). Rains in excess of 52mm that is common in September in the agro ecological zone will definitely affect negatively the quality of the lint.

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